New Turbine Workshop

Introduction: Turbine system basics & building real machinery

By Ken Rieli

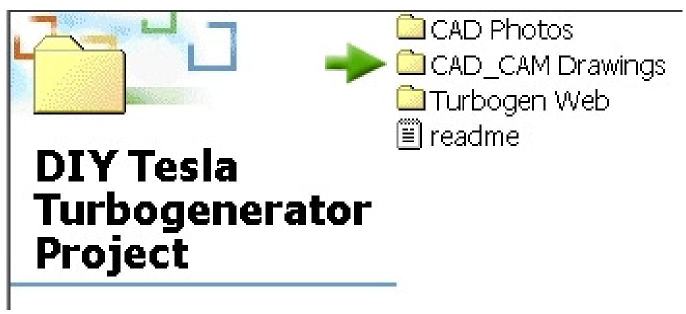
Hello, and welcome to the New Turbine Workshop.

My name is Ken Rieli, and I am your instructor in this educational series aimed at designing and building disc turbine systems.

In this opening article we will cover some of the basics of the turbine system itself, and the methods & processes of building real machinery.

Using CAD_CAM Drawings

By now you already have your CD and have probably taken the time to study its contents. If not, take the time to familiarize yourself with the basic construction of the 7-inch turbogenerator as that will be the unit we focus on in our articles.



As you explore the CD contents, you will notice that we have included a Drawings section with DWG files.

We use these files in BobCadCam to generate tool path data for CNC machines.

Since BobCadCam is a bit pricey for most people, you may want to download and try a free program called HEEKSCAD-CAM. We haven't personally used this program yet, so if you find it does work, let us know.

Another pathway to generating tooling code is TurboCAD-Cam. This is not a direct route since the files must originate in TurboCAD. Once the tooling code is generated, it is then imported into a CNC machine control program such as EMC2 (linux), Mach3 (Windows), or CNC Zeus (DOS).

EMC2 is my first choice, and is open source, while Mach3 and CNC Zeus both offer limited free versions.

An alternative to going through the CNC process is to simply send the DWG files via email to your CNC service provider, or simply turn out the parts yourself on manual machines.

Since all of our turbomachinery was built using manual tools, we'll take that approach as we go through the build process.

Now let's take a look at the complete solar turbogenerator system.

Solar Turbogenerator System

In Figure 1 we see a computer snapshot of a closed loop steam or ORC system.

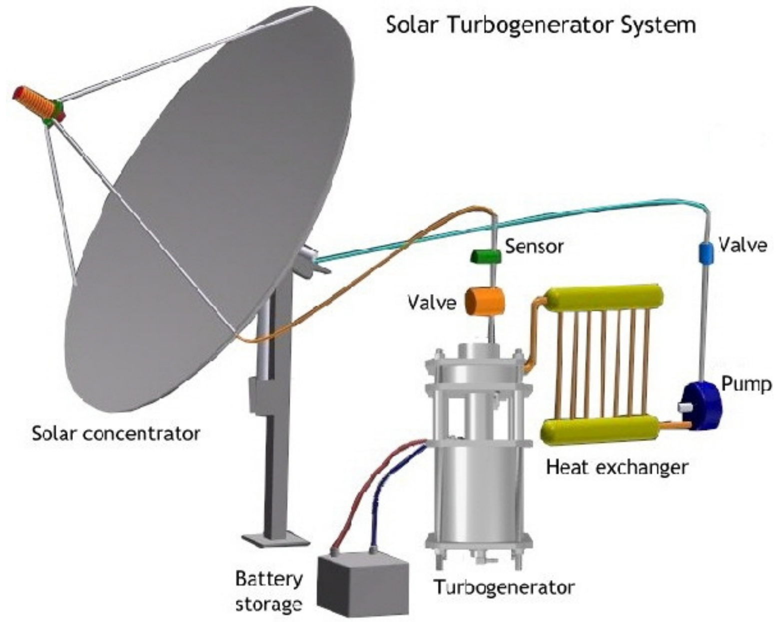


Figure 1

The solar concentrator may be of the dish or trough type, but not flat plate, as the flat plate operates at less than 200 degrees F (insufficient for generating 150-200 psi).

Generally speaking, dish concentrators operate at about 750°-1200° F - which is alright for steam, but too hot for ORC (ORC fluids begin to break down at 350° plus temperatures).

Solar troughs, on the other hand, operate at about 300°-375° F maximum – which is ideal for both steam and ORC operations. That is the approach we will take for this study. Troughs are relatively easy to construct, and offer the best temperature range for closed-loop systems.

Pressurized gas leaves the concentrator and passes through a pressure control valve and into the hot rotor section of the turbogenerator. The pressure control valve is normally closed, opening once the sensor indicates a gas pressure between 150-200 psi.

Pressurized gas expands in the turbine rotor to create mechanical motion, and in the process drops from roughly 150 psi to 1-2 psi. This 1-2 psi gas exits the turbine and is relatively condensed back into a liquid in the heat exchanger expansion nozzle – under vacuum.

Upon leaving the condensing heat exchanger, the differential pump forces the liquid through a check valve back into the solar concentrator head, completing the cycle.

Two-stage Simple Mode ORC Diagram

In Figure 2 we see a 2-stage, simple-mode ORC block diagram of our system. Two-stage systems use oil to transfer heat from the concentrator to a heat exchanger, where the ORC fluid is heated and expanded into pressurized gas.

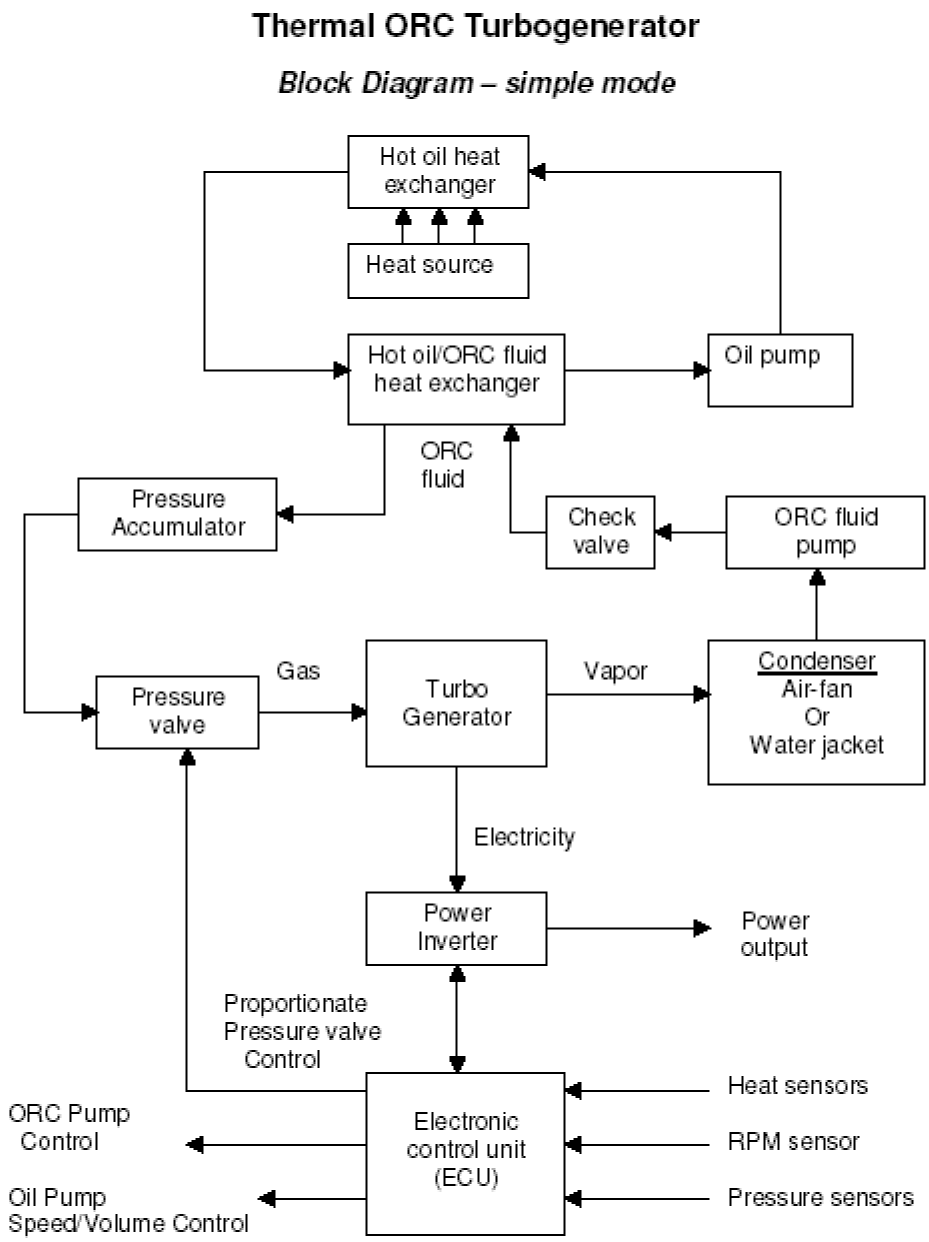


Figure 2

It is a simple mode system in that heated and pressurized gas is used only once to drive a single turbine stage – the latent heat being used for facility or process functions rather than to drive a secondary turbine.

This 2-stage system is different from our Figure 1 system in that single stage systems heat the expansion fluid directly.

Two-stage systems are more complicated using a 2-step process for heating the expansion fluid; they are, however, more reliable because the heat transfer oil is not under pressure, so there is less danger of losing the ORC fluid. This is especially important when dealing with customer-oriented products.

Again referring to our Figure 2 block diagram, we see that the ORC system consists of 3 unique sections:

1. The topmost section is the heat concentrating unit. Oil circulates through the solar receiver where it is heated to about 325-350 degrees F. The hot oil transfers a large percentage of this heat to an ORC fluid in the hot oil heat exchanger. The oil is then re-circulated back through the trough receiver.
2. The second section is pretty much identical to the single stage ORC turbogenerator system described above.
3. The third section consists of a power inverter/regulator and an electronic control unit to analyze sensor inputs and regulate pumps and valves.

That just about wraps up this discussion of the system design.

In the months ahead, we will cover:

- construction details of the turbogenerator itself
- a low-cost approach to trough building
- electronic control units to track the sun, regulate voltage and current storage, and regulate the electro-mechanical components for efficient system operations.

By the end of this course, you will be well on your way to independent living and freedom from centralist extortion.